FRED Reports

OPERATION OF THE SUSTAF 10^6 DEVICE FOR SORTING PINK SALMON EGGS

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ABSTRACT

Electronic sorting devices have become the most common means of picking salmon eggs. The newest sorter in use is the Sustaf 10^6. Sorting speeds of over 700,000 eggs per hour have been obtained. In order to achieve near advertised levels of efficiency, close attention must be paid to some procedural details. These details (not provided by the manufacturer) were learned by experience at Kitoi Hatchery. Drum size selection, water flow rate, and routine cleaning are simple but important requirements for obtaining rapid picking speeds. Changing the power supply, motor brushes, and ejector coils are discussed, as they are necessary tasks to insure clean and rapid sorting. Adjustment of photoelectric lenses to select and reject dead eggs is also discussed.

KEY WORDS: Pink salmon, Oncorhynchus gorbuscha, fish culture,egg sorting, Sustaf 10^6 egg sorting device, maintenance, adjustment.

INTRODUCTION

Large production hatcheries have been hindered in the past by the time-consuming, but critical, task of sorting dead and live eggs. Many methods have been employed for this, ranging from manual removal of individual eggs to the use of electronic sorting machines. The subject of this paper is a recently-developed rapid sorting machine called the Sustaf 10^6 electronic sorter (Kepshire 1983). All the Sustaf machines are made in Italy and sold in the United States by the distributor: Troutlodge, Inc., McMillin, Washington. The Sustaf 10^6 is advertised to sort 1 million eggs per hour. This machine has been used throughout the State of Alaska, but not without problems. The lack of adequate instructions about the machine's operation has caused unintentional abuse, sometimes resulting in disillusionment with the machine's capabilities. In this report I provide simple instructions for the efficient operation of the

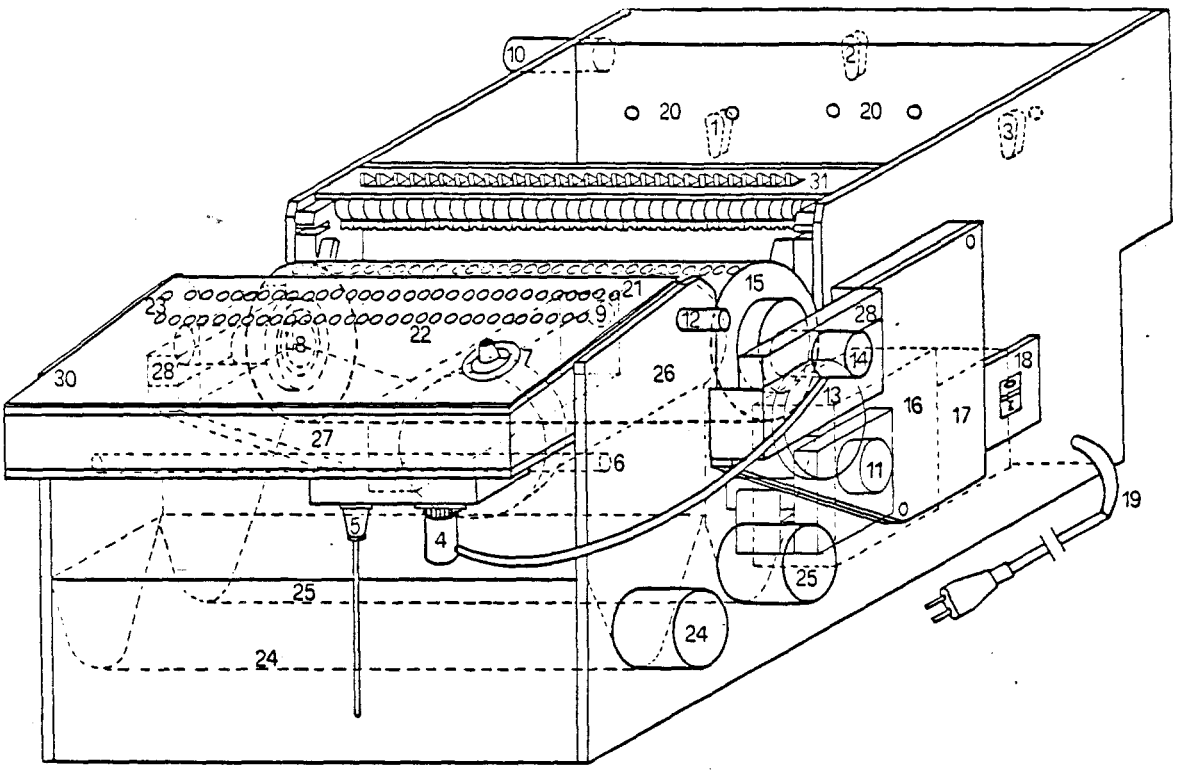
machine as well as some methods to solve some of the minor problems that can occur. This report is an instructional guide for the use of the machine, and it makes no claim as to the quality of the product.

MATERIALS AND METHODS

The operation of the Sustaf machine is based on reflection of infra-red light from salmonid eggs. The quantity of light reflected to the sensing lens from dead eggs and live eggs is different. The threshold at which the machine detects the reflected light (thereby rejecting the dead eggs) is controlled by several electronic and physical adjustments.

Prior to loading eggs into the unit, the machine should be turned on so that it can warm up and stabilize for a few minutes. The eggs are then loaded into the egg basin (Figure 1), and the water flow is adjusted to move the eggs toward the rotating drum. The drum contains rows of perforations that pick up the eggs. The drum then carries the eggs past two lenses that sense the difference between light reflected from the white, dead eggs, and live eggs. A white egg activates the rejection circuitry. This causes a small port to open, allowing a jet of air to push the dead egg out of the drum perforation. The dead egg is pushed out past a dividing wall into a discharge channel. The live eggs continue around the drum until they reach a 6 o'clock position. There, a constant stream of air blows them into another discharge channel. In this way, separation between the live and dead eggs is accomplished. The machine cannot differentiate between live eggs and "blanks" (or clear, but dead eggs), so the shocking process must occur prior to sorting and must be of sufficient strength to turn all the dead eggs white.

The Sustaf 10^6 has been used for sorting pink salmon (Oncorhynchus gorbuscha) eggs at Kitoi Bay Hatchery for three seasons. In 1983 over 104 million pink salmon eggs were sorted with the machine. The average sorting speed has improved with each year of use. In 1983 an average speed of 700,000 eggs per hour was reached; the fastest hourly speed



1. Drum cleaning regulation tap
2. Regulation tap for egg basin water
3. Water cleaning regulation tap
4. Station ejection connector
5. Feeding connector
6. Cleaning unit for ejected eggs canal
7. Sensitivity regulator
8. Water lubricated plastic bearing
9. Compressor air-intake
10. Water feeding pipe
11. Drum driving motor
12. Station dowel pin
13. Drum movement transmission
14. Ejection unit for unusable eggs
15. Perforated drum for egg transport
16. Feeding transformer unit
17. Feeding stabilizer
18. Ignition lock switch
19. Feeding cable
20. Egg basin
21. Red LEDs - visualization control
22. Green LEDs - ejection control
23. LED - control gauge
24. Discharge canal for ejected eggs
25. Discharge canal for good eggs
26. Air compressing motor
27. Ejector air pipe
28. Drum fixing supports
30. Visualization and ejection control station
31. Drum cleaning unit

Figure 1. Sustaf 10^6 Schematic. Taken from Sales and Service Leaflet for Sustaf 10^6.

obtained was 800,000 eggs per hour. Minor repairs to the machine and improved techniques in its operation promise to increase the average number of eggs sorted per hour in the future.

Operation of the Sustaf Egg Sorting Device

There are three factors that must be considered in order to achieve maximal efficiency from the Sustaf machines: selection of drum perforation size, waterflows, and machine cleaning.

Selection of Drum Perforation Size:

Selection of a drum with the proper size perforations is extremely important. Two drums having different perforation sizes are supplied with each machine: large (9.25-mm perforation diameter) and medium (7.25-mm perforation diameter). A third size drum perforation used for trout eggs is also available, with a perforation diameter of 5.25 mm. The eggs should fit into the perforation with little room for movement. At the same time, they must fit down into the perforation with enough clearance to allow easy ejection and to enable them to be picked up as the drum rotates. The large size drum was used at Kitoi Bay for picking pink salmon eggs (Figure 2). The average egg diameter of live pink salmon eggs at Kitoi Bay Hatchery was 6.64 mm. Dead egg diameters vary widely and have a larger mean diameter than live eggs. The drum perforation must accommodate both live and dead eggs.

Some of Alaska's chum (O. keta) and chinook salmon (O. tshawytscha) have egg sizes which do not fit the largest drum size. Examples are the Wells River chum stock used at Main Bay Hatchery and chum from Cold Bay. At this time there is no way to deal with this problem.

Selection of the proper size drum will also increase the accuracy of the electronic sensors in detecting dead eggs. Once the machine has been adjusted to reject dead eggs, but not live eggs, changing the distance from the egg surface to the photoelectric lens will change the sensitivity of individual photoelectric lenses and will require readjustment.

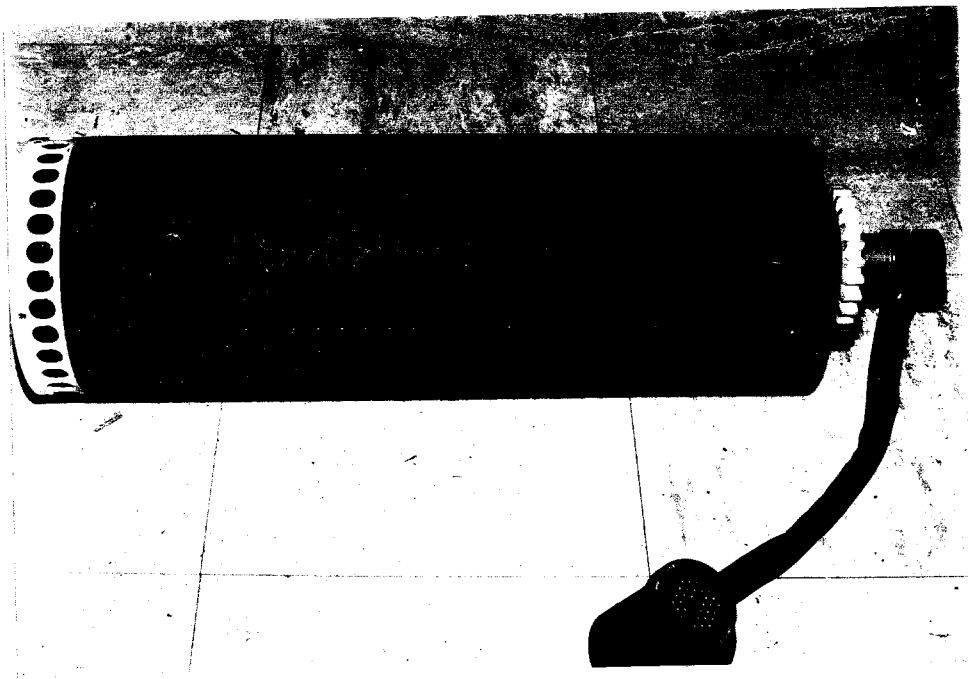


Figure 2. Drum for Sustaf 10^6.

Using the same size drum for sorting two different species of fish eggs (i.e., pink salmon and chum salmon) causes one species' eggs to be closer to the photoelectric lenses, resulting in less than perfect sorting. The system should be recalibrated with a species change for optimal operation.

Waterflows:

The Sustaf 10^6 works best when a constant water pressure (greater than 20 psi) is supplied. Pressures less than 20 psi will not wash the drum or the dead egg chamber properly.

Waterflows to drum wash should be set as high as possible without splashing water onto the photoelectric lenses. Depending on the water pressure used, each machine will have its own best setting. The water to the drum wash is regulated by a black lever on the end of the machine containing the egg basin (Figure 3). Waterflows to the dead egg chamber should be set at a rate near the maximum to insure adequate washing. The water to the dead egg chamber is also regulated by a black lever on the end of the machine containing the egg basin (Figure 3).

The water to the egg basin is regulated by the middle black lever on the end of the machine (Figure 3). Waterflow to the basin should not be so high that eggs are carried over the drum when the basin is loaded. At the same time, waterflows that are too low will not allow the drum to pick up eggs efficiently and will result in many empty perforations. Low flows will also break some eggs as they do not easily slide past the drum and frame contact areas. This flow rate will vary according to the pressure of the water used.

Flow rates are the most important aspect in achieving the maximal machine efficiency. No one particular setting will work for all machines. Different species and even different egg lots will require some adjustment to the waterflows. Experience is the best teacher.

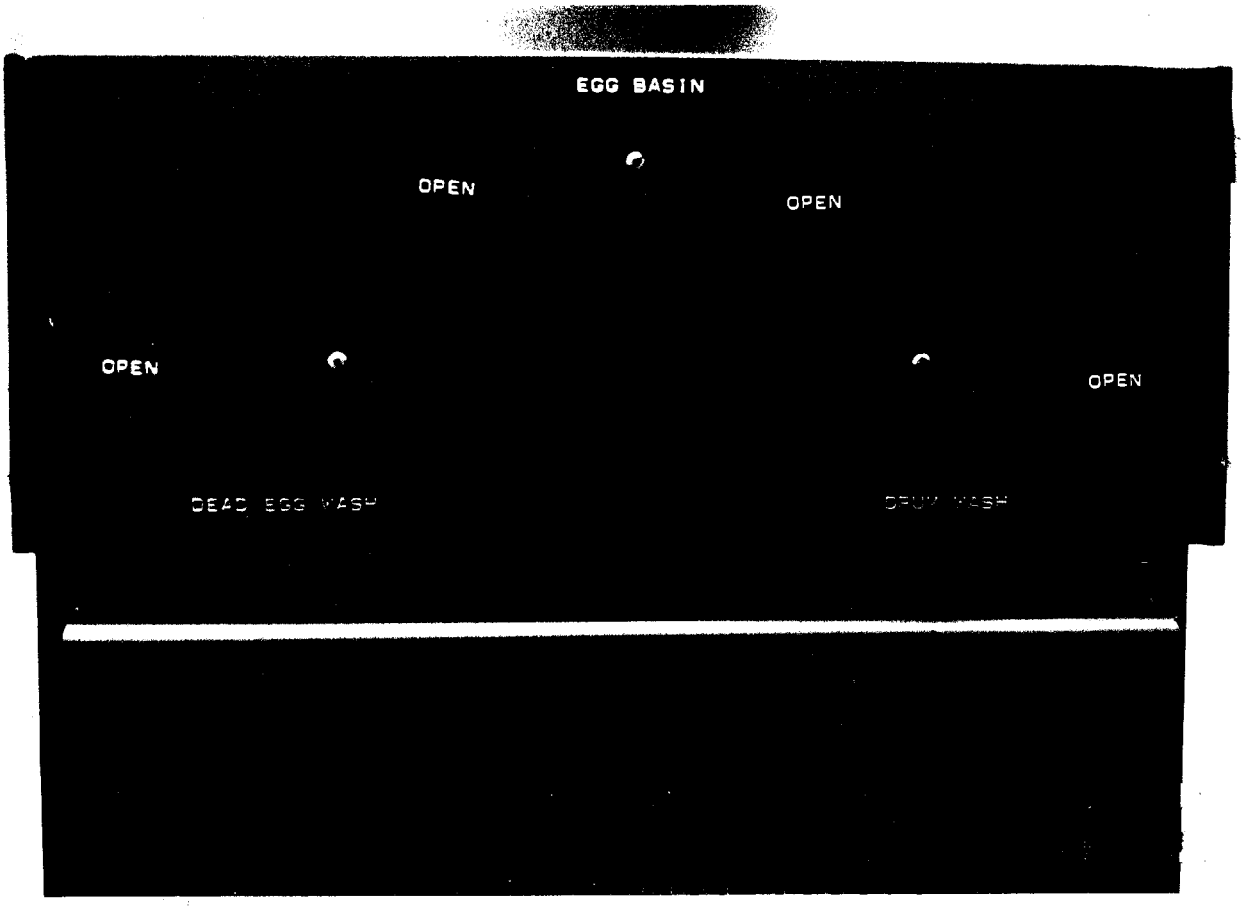


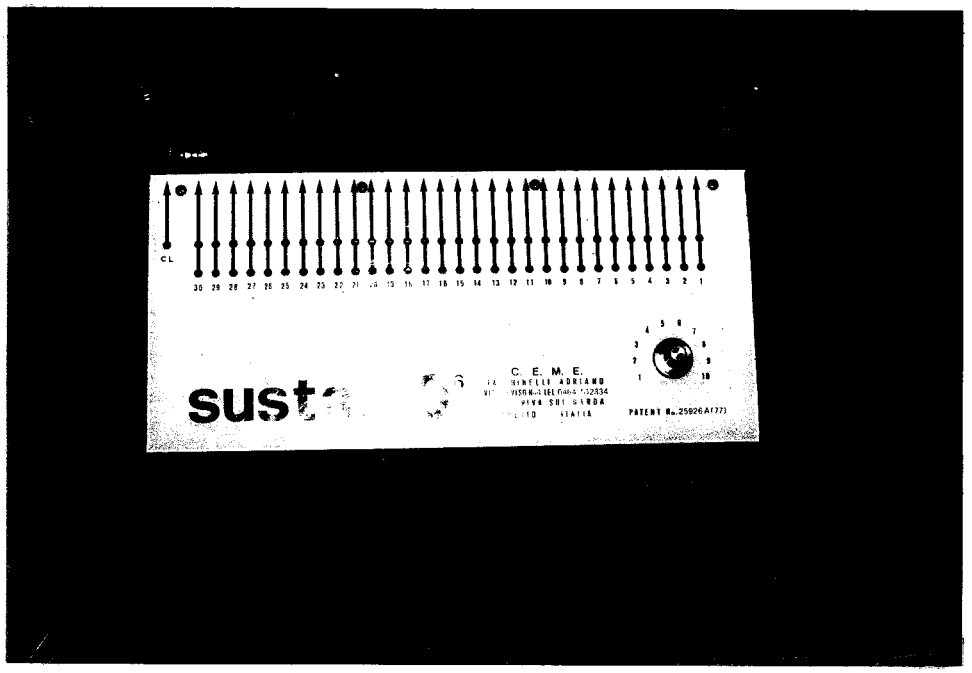
Figure 3. Waterflow adjustment knobs.

Machine Cleaning:

The Sustaf machines should be cleaned every day to insure sorting accuracy and efficiency. The photoelectric lenses on the control panel should be cleaned with cotton swabs after each day's sorting. Never use anything that can scratch or mar the lens. Cleaning the lenses is best accomplished by removing the power supply attachments, backing off the black plastic lugs located on each side of the control panel, and lifing the control panel out (Figure 4). Reinstallation of the control panel is accomplished by reversing the process.

A thorough washing of the machine is accomplished by removing the drum along with the control panel and then washing the egg basins with a light spray of water. Caution must be used to avoid putting water into the drum air supply port. The drum is removed by detaching the power supply from the control panel, by pulling straight up on the drum washing unit, by backing off the two bolts on each side of the drum fixing supports, and by lifting the drum out (Figure 5). Light water pressure can also be used to clean the drum. Never immerse the drum in water because the electrical components can be damaged. Replacement is the reverse process of removal. Caution must be used in tightening the bolts on the drum fixing supports as they are metal bolts on plastic threaded fittings. Overtightening will strip the plastic. Tighten only until snug. The bolt requires a 10-mm wrench.

At the end of the season or during disinfecting, the skin can removed from the drum for thorough cleaning. Before removing the skin, place alignment marks on both ends of the the skin and on the plastic end pieces. Eight small screws, four to a side, can now be removed along the edges of the skin (Figure 2). The skin will then slide off the drum, allowing access to the internal area for cleaning and disinfection. Do not immerse the internal drum components in water. The drum skin is replaced by sliding it back over the drum and aligning the marks. Tighten the screws so the screw heads do not extend above the surface of the skin.



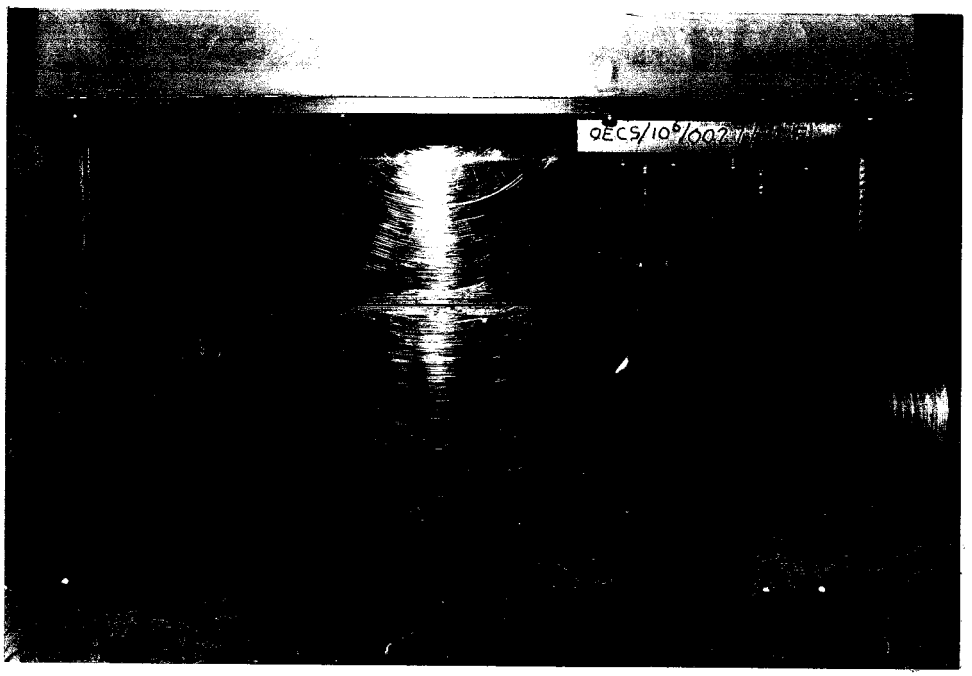


Figure 4. Control panel LED's and sensitivity dial; power hookup, observation window and cover screws.

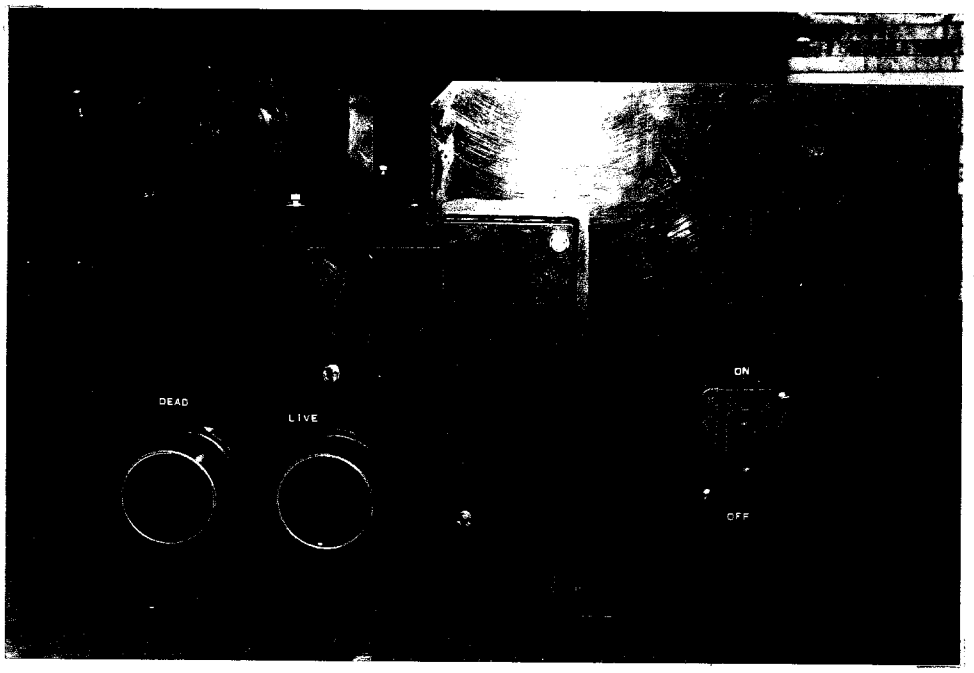


Figure 5. Drum supports, on/off switch, egg outflows, plastic lugs holding control panel.

Maintenance of Critical Electrical Components

There are four important electrical components which greatly affect the Sustaf's efficiency and life expectancy: the power supply; photoelectric lens (adjustment); ejector coil (testing and replacement); and motor brushes (which need changing periodically). There are other electronic components which can fail, but these require the skill and knowledge of an electronics expert to repair or replace.

Power Supply:

All machines destined for U.S. markets are wired for 110 volt, 60 hz power supply. Fluctuations in the power supplied to the machine may cause erratic sorting. Many of the remote hatchery locations generate their own power, or they may receive power from small power plants that do not have the capability of producing a steady flow of electricity. The simplest solution to most power fluctuation problems is the installation and use of a voltage regulator (Figure 6). Kitoi Bay Hatchery uses a SOLA CVS regulator with a 2,000 VA (watt) rating. This regulator is manufactured by SOLA Electric: a unit of General Signal, 1717 Busse Rd., Elk Grove, Il.

Photoelectric Lens Adjustment:

The Sustaf 10^6 has 30 photoelectric lenses, one for each column of perforations in the drum. One master lens synchronizes the impulses to the sorting lenses (Figure 7). As the drum rotates, the LED (light-emitting diode) on the master lens flashes red as each row of perforations passes. The red flash indicates that the circuitry in all the sorting lenses has been re-set and that the lenses are ready to look at the next row of eggs. If the LED on the master lens does not flash red, the drum perforations should be checked to see that nothing is blocking the master lens' view. Sometimes the lens may be blocked by water or debris. If the master lens does not flash after the system is cleaned and checked, a minor adjustment to a variable resistor in the

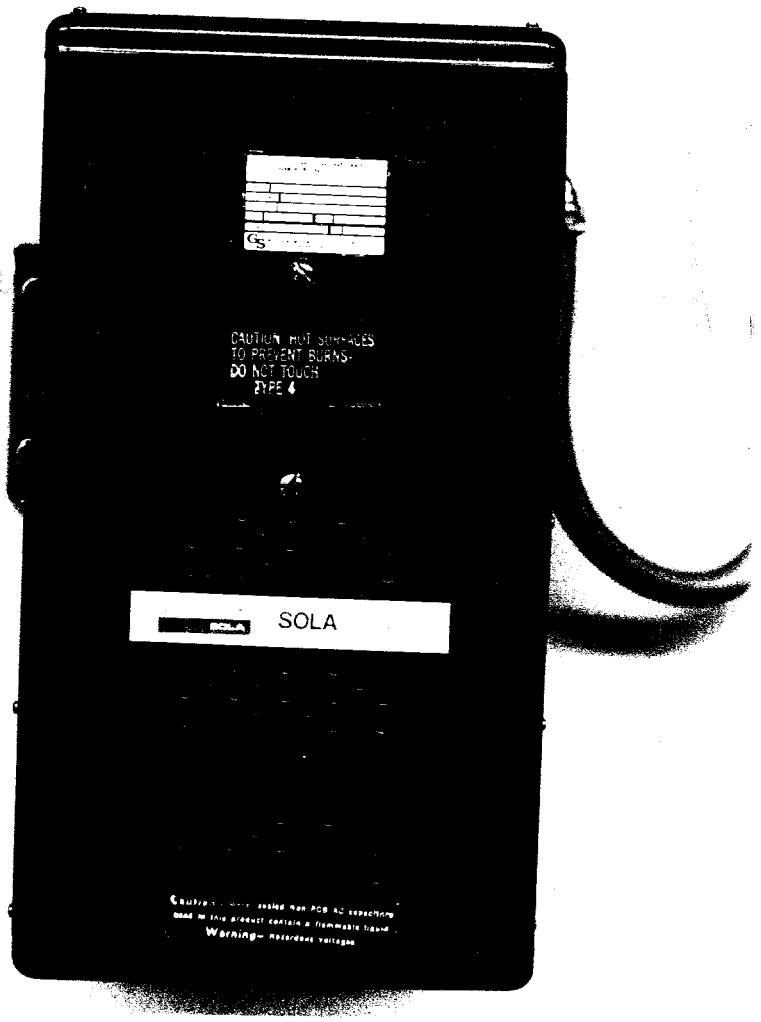


Figure 6. Sola CVS voltage regulator.

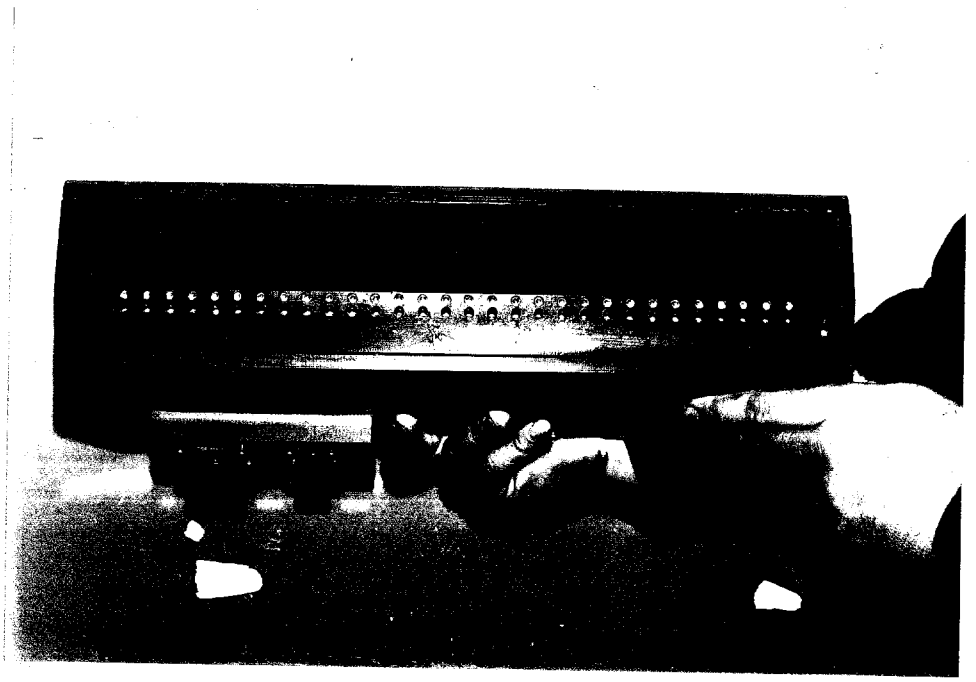


Figure 7. Photoelectric lenses on control panel.

circuitry inside the control panel may be necessary. The control panel is identified by the manufacturer's name and address embedded in the plastic cover. The control panel has a row of four screws across the top front and bottom rear. Removal of these screws allows entry to the circuit boards (Figure 4).

The control panel contains two printed circuit boards, one above the other. Removal of the circuit boards is not recommended or necessary. Major repairs will require a qualified electronics expert.

The bottom circuit board contains a row of variable resistors. These devices control the sensitivity threshold of the photoelectric lenses to reflected light. These resistors need to be periodically calibrated to each other, so that each lens will react to the same amount of reflected light. A row of small holes are located in the top circuit board through which a small screwdriver can be inserted for this adjustment (Figure 8).

The variable resistor has on its top surface a small plastic screw that can be turned for adjustment. Before making any adjustments, make sure the photoelectric lenses are clean and free of water. The sensitivity dial located on the top right side of the control panel should be set between 5 and 6 for any adjustments.

Adjustment of the photoelectric lenses requires the use of live and dead eggs of the target species. This is done as follows: a row of perforations is filled with live eggs and taped in place with clear scotch tape. Another row of perforations is filled with dead eggs and taped in place. (The use of plastic beads is not recommended as their size and reflectivity is considerably different than salmonid eggs).

After the eggs have been securely taped in place and the cover removed from the control panel, the machine is ready to be energized. (Do not use any water in the machine during this process). As the drum rotates, the red and green LED's should light each time the row of dead eggs pass. No lighting of the LED's should occur when the live eggs pass. If some LED's

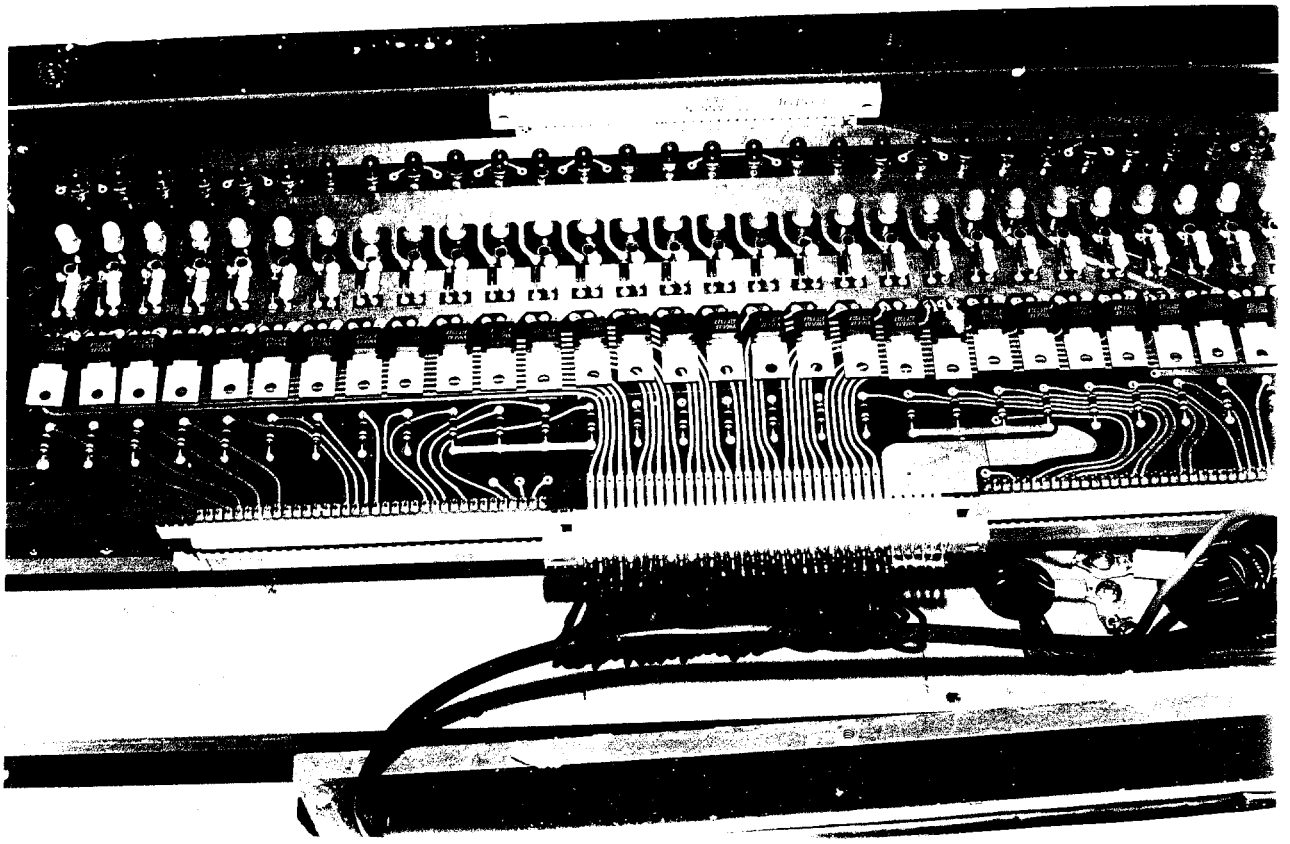


Figure 8. Top circuit board showing LED's, access holes to variable resistors and various transistors.

do not function in this manner, the variable resistor for those rows should be adjusted. A setting too high will cause the LED's to light on both live and dead eggs. A setting too low will cause the LED's to fail to light on the dead eggs. This adjustment can be made by inserting a small plastic screwdriver through the hole in the top circuit board immediately in front of the red LED, and turning the screw in the variable resistor counterclockwise until the LED lights up when a dead egg passes. A setting too high will cause the LED to light up when the row of live eggs pass; it must be backed down so that the LED lights up only on the dead eggs. The screw adjustment on the variable resistor is very sensitive, and a very slight movement will correct the problem.

Sometimes an LED will light up when the live eggs pass, suggesting high sensitivity. Prior to making any adjustment, check the row of live eggs for overlapping scotch tape. The double thickness of the tape changes the reflection of light and may cause false sensings. Stop the machine and correct the double thickness of tape. If the LED still lights when the live eggs pass, the sensitivity of the variable resistor is too high and must be adjusted lower. After 10 minutes of operation the eggs taped to the drum will have dried, and false readings may begin to occur. The eggs need to be replaced with fresh eggs and retaped before continuing.

After all the photoelectric lenses are working properly, switch the machine off and lock the variable resistors in place with fingernail polish. The fingernail polish can be applied with a hypodermic needle and syringe. Locking the variable resistors in place is necessary as vibration from the machine's operation will tend to change the sensitivity adjustment of variable resistors. Allow the fingernail polish to set about 15 minutes, replace the cover on the control panel, and then place a mixture of live and dead eggs in the egg basin. Start the machine as in normal operation and observe the LED's. Turn the sensitivity dial on the control panel until the best sorting occurs. Any row that is not picking properly can be individually adjusted to get perfect picking. After complete adjustment is made, switch the machine off and allow the fingernail polish to finish hardening for about 12 hours.

During operation, water may splash onto the photoelectric lenses of the machine. The eyes will not sort properly if they are covered with water. To correct the problem, switch off the machine and clean the photoelectric lenses with a cotton swab, removing all water.

Ejector Coils:

At times the Sustaf 10^6 will not sort properly even though all the LED lights indicate dead eggs are being ejected. The problem can usually be corrected by replacing or repairing ejector coils inside the drum. The faulty coil can be isolated by stopping the waterflow to the dead egg chamber and observing with a flashlight through the plastic window the row not ejecting dead eggs. Moving the lever for that row on the drum washing unit should stop eggs from being carried by that row of perforations (Figure 9).

Another, more positive, check to isolate a faulty coil is with an ohm meter. Each coil can be checked at the power supply connection between the drum and control panel. Detaching this connection yields a coupling with 37 numbered holes (Figure 10). Each of the first 30 holes corresponds to an ejector coil for that row inside the drum. The last seven holes are ground circuits. When the negative probe of the ohm meter is placed into any one of the ground circuits and the positive probe into one of the coil circuits, about 70 ohms should be indicated. If this reading is not indicated on the meter, then that circuit is open, and the fault is usually in the coil.

The coils are reached by removing the skin from the drum and then removing the 14 screws that hold the plastic housing around the coils (Figure 11). The suspected coils can then be checked directly with the ohm meter. The most common cause of ejector coil failure is a broken wire in the coil. Oftentimes, the wire is broken at the soldered connection and is easily fixed. Otherwise it must be replaced. A coil can be removed by backing

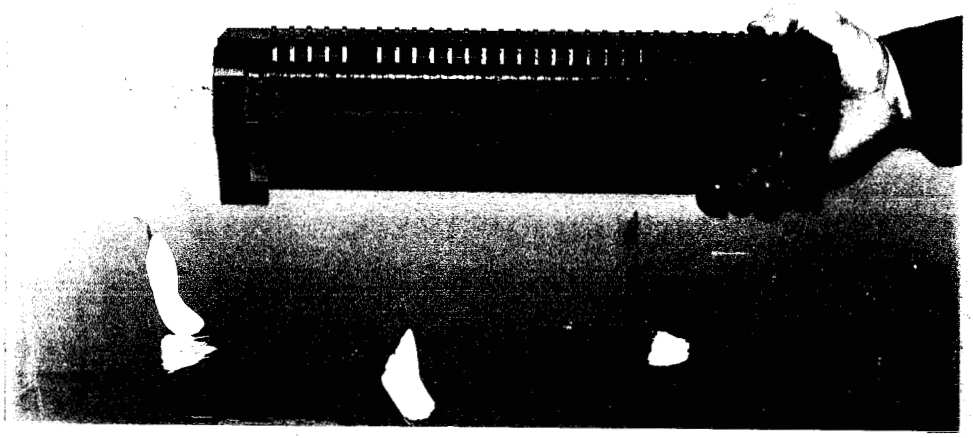


Figure 9. Drum washing unit.

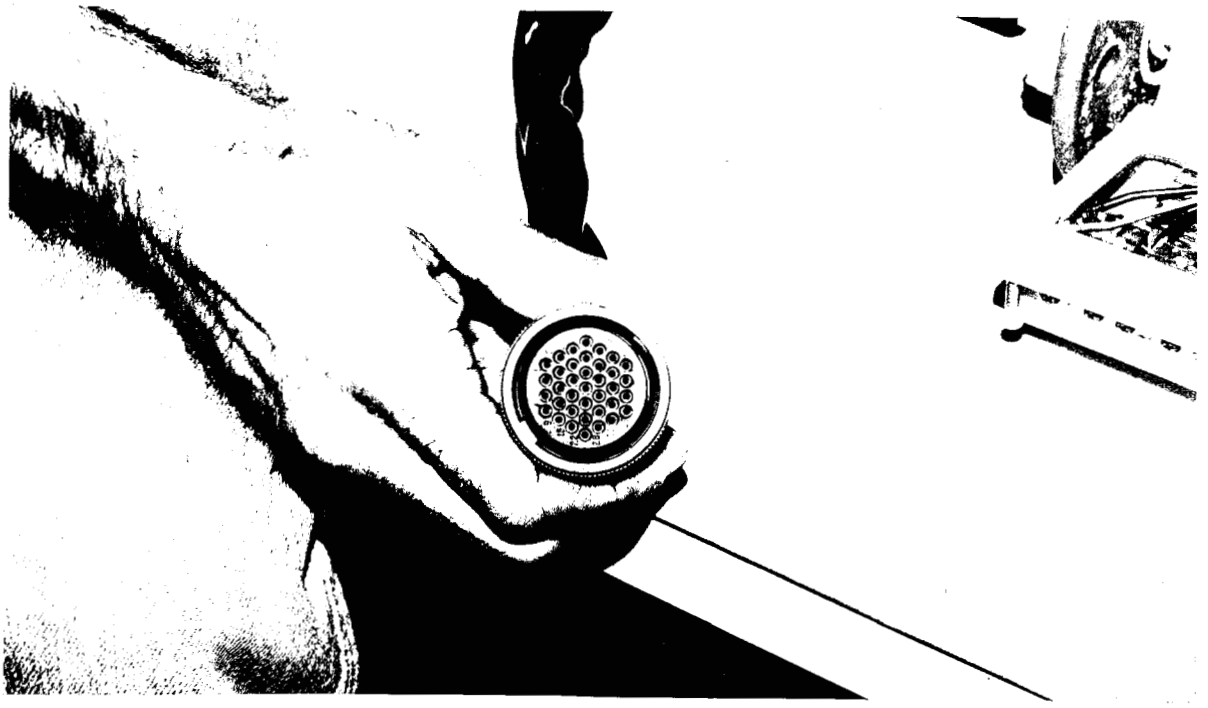


Figure 10. Drum connection from control panel showing power supply receptacles.

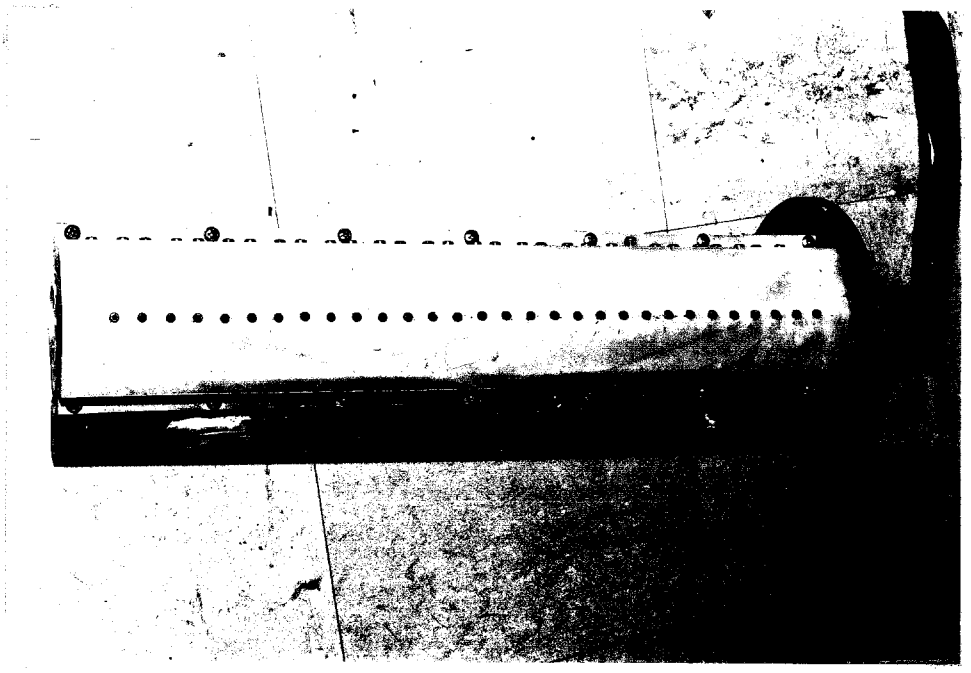


Figure 11. Drum with skin removed showing 14 screws holding plastic housing together.

out the two screws that mount the coil to the plastic frame (Figure 12) and loosening the solder from the two wire connections (Figure 13). A new coil is put in by the reverse order.

The ejector coils will generate small amounts of heat each time they are activated. If insufficient off-time does not occur, as when resorting dead eggs, it is possible to burn out the coil. Resorting dead eggs should only be done as a last resort, and enough live eggs should be added to allow sufficient off-time for cooling. Never operate the machine when there are more than 50% dead eggs.

Motor Brushes:

The electronic motors, which drive the machine, are located inside the plastic housing under the egg bin. These motors are driven by brush contacts on the rotor. These brushes will wear with use and must be replaced when worn. The first indication of brush wear is erratic cycle changes in the motor's sound, decreased speed in the motor, and a hot electrical smell.

Access to the motor is accomplished by removing the bottom plate under the machine, which is held in place by six bolts (Figure 14). Each brush on the air blower motor is held in place by a simple snap lock. If the lock is depressed, the brush and spring will then slip out. After putting the new brushes in place, replace the snap lock and reseal the bottom cover with fingernail polish. Do not seal the plates with silicone sealant, because if this sealant is used, later re-entry can result in damage to the plastic housing. The bolts attaching the bottom plate should be snug, but not over-tightened as the plastic threads will strip against the steel bolt threads.

There are other electronic problems that can occur with the machine, but these are usually located within the components of the circuit boards. These components are very sensitive and should be checked and replaced by a qualified electronics expert with the proper test equipment.

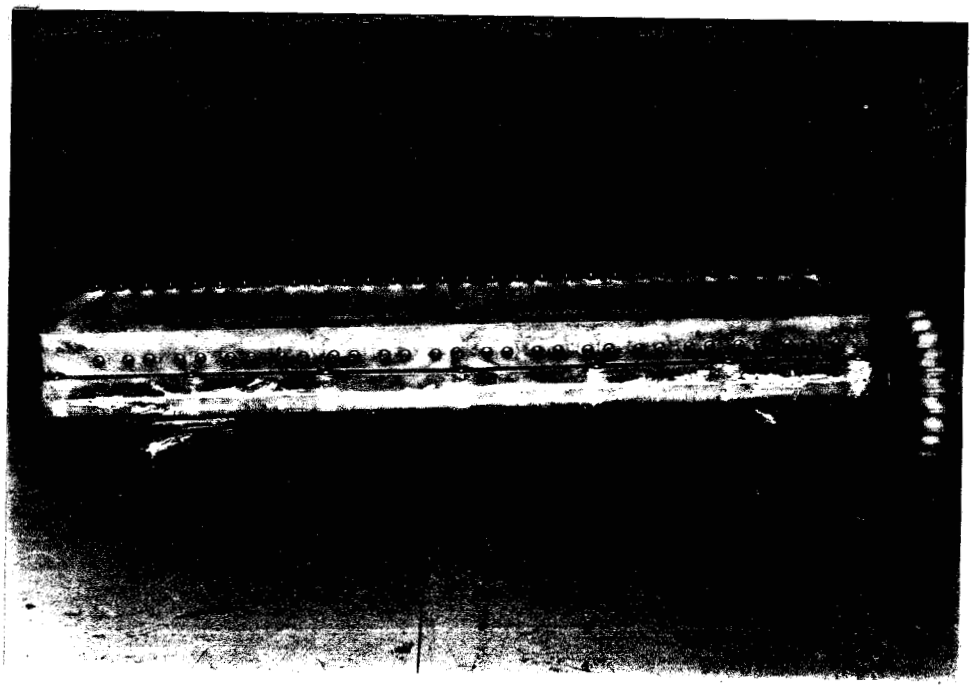


Figure 12. Ejector coil support screws.

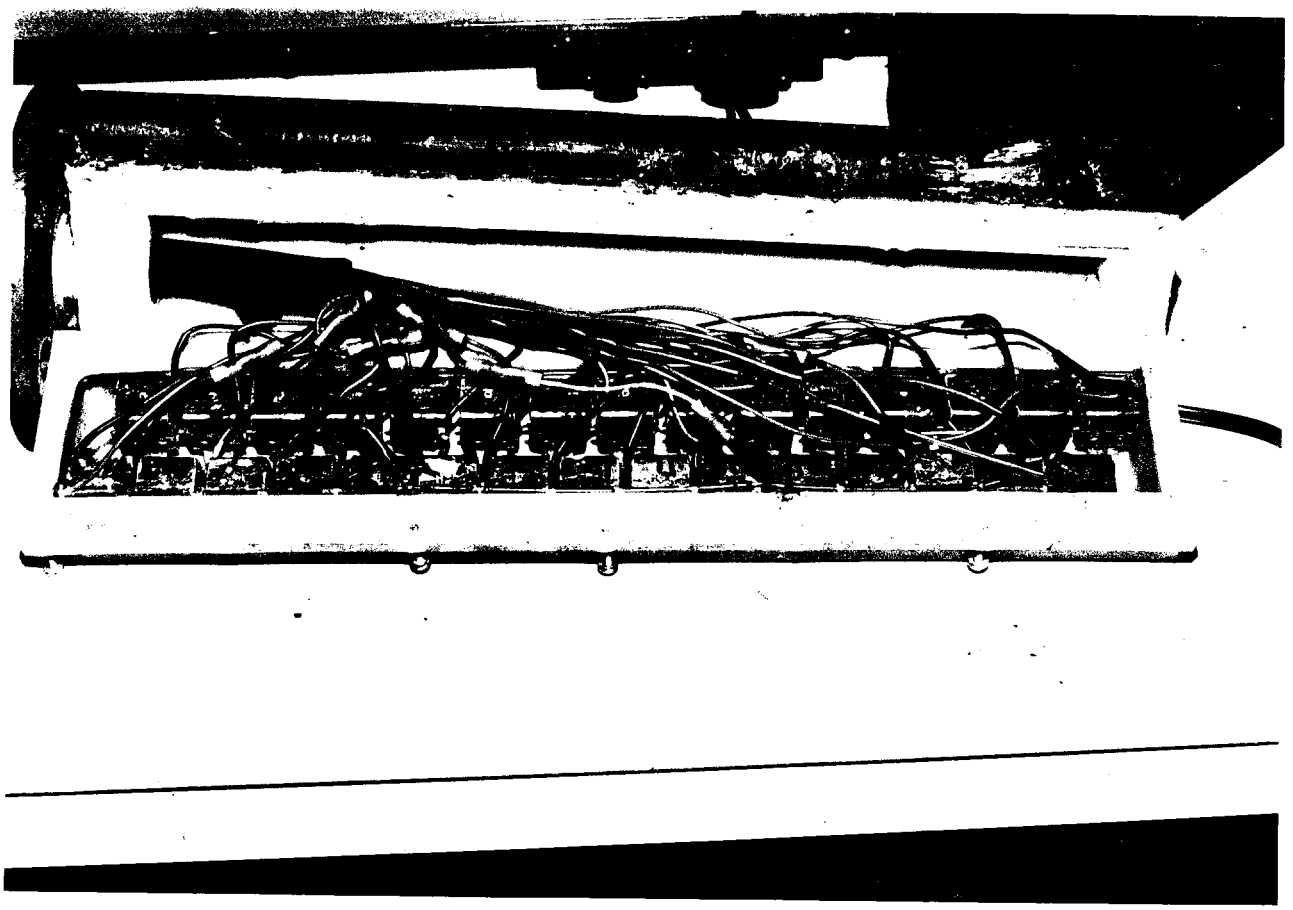


Figure 13. Coils inside drum showing wire connectors.

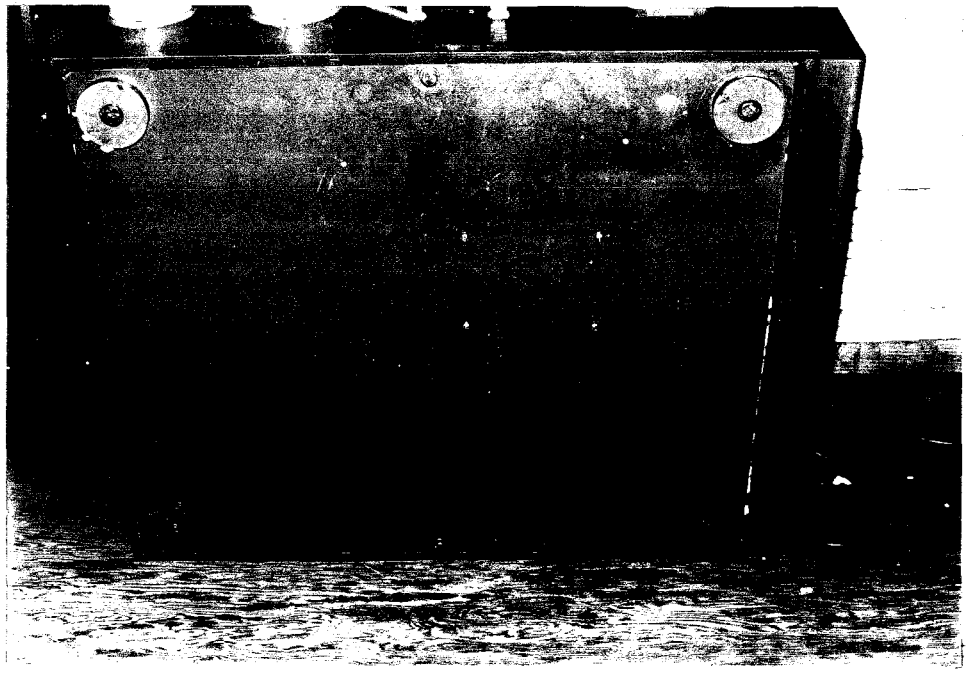


Figure 14. Access to power supply and vacuum meter.

DISCUSSION

The Sustaf machines will sort eggs very rapidly and accurately with the proper operation and maintenance. These simple guidelines will hopefully provide a starting point for developing the best techniques for each species and facility.

ACKNOWLEDGMENTS

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